MAGNETIC RAYS.

THE complex phenomena that occur at the kathode of a vacuum tube in the presence of a magnetic field have given rise to numerous researches since the time of

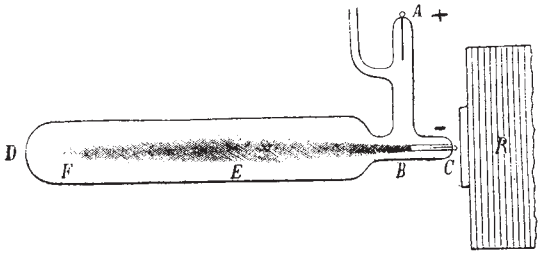

FIG. 1.

Plucker, and a great number of the effects observed still await an explanation.

Birkeland has shown that if a cylindrical discharge tube is placed in a longitudinal magnetic field of gradually increasing strength, there is at a certain value of the field an abrupt fall in the potential at the terminals. Almy has connected this with a sudden change in the appearance of the discharge. Willows has found that a transverse field causes the discharge to pass more readily below a certain value of the gas pressure; according to Peck, this effect is not found if the kathode fall of potential is greatly reduced by the use of a hot lime kathode. Broca has discovered that, in addition to the kathode rays which go in helices round the lines of force, there is produced a second species which follow the lines. Villard calls these magneto-kathode rays, and has shown that they are deflected by an electrostatic field, but in a direction *perpendicular* to the latter. By directing them into the interior of a Faraday cylinder, he has been unable to prove that they carry a charge; the experiment is, however, not conclusive, because the conducting power of the surrounding gas may be sufficient to disperse any charge so collected.

FIG. 2.

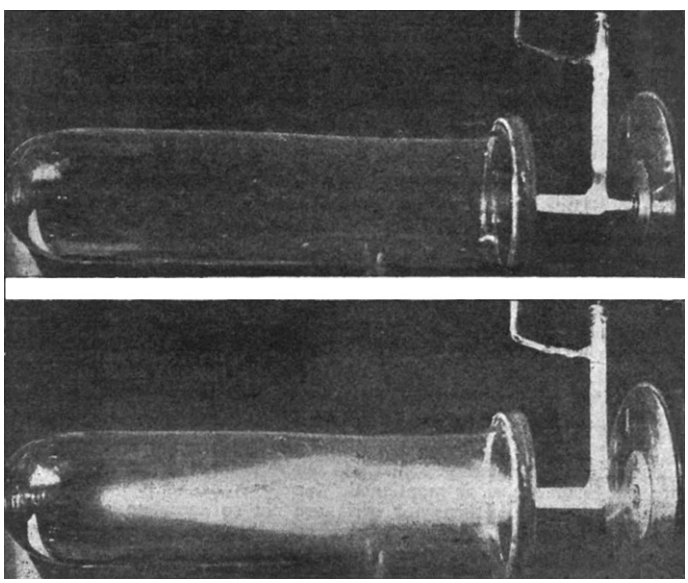

FIG. 3.

In a recent paper by Righi (*Accad. d. Sci., Bologna*, May, 1908) the hypothesis is made that these rays are electrically neutral doublets, more or less unstable, consisting of an electron and a positive ion rotating round each other. On account of its larger mass, the latter may be looked upon as stationary while the electron moves in an orbit around it. If the plane of rotation is perpendicular to the field, the force acting on the electron, arising from this field, will be radial, and the doublet may have stability conferred upon it. If the plane of rotation is inclined to the field, the electron, and hence also the doublet, will tend to move up or down the lines of force. Such doublets he calls magnetic rays, because the magnetic field is necessary to their stability. Fig. 1 shows one form of tube used by Righi in his efforts to demonstrate the existence of such rays. A is the anode, C the kathode, R an electromagnet; the source of current is a Holtz machine. Figs. 2 and 3 show the appearance of the tube when the discharge is passing, while the magnet is off and on respectively. The part BE (Fig. 1), according to the author, consists of the rays in question; to the left of E the field is too weak to confer stability on the doublets. The luminosity, EF, behaves, to a magnet, like the positive column of the ordinary discharge, but with E as anode and F as kathode. Fig. 4 shows the effect of a transverse magnetic field on this column. In order to obtain the magnetic rays the field has to exceed a certain value, depending on the gas pressure, and when this value is reached the discharge becomes intermittent, as may be shown by a rotating mirror or telephone. The period increases with the field. The paper contains numerous photographs and measurements of the discharge under different conditions, and there is no doubt of its interest and suggestiveness, although it cannot be said to have demonstrated the actual existence of the hypothetical rays.

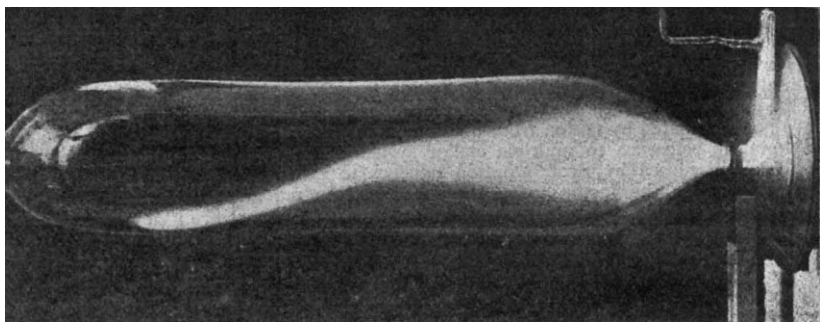

FIG. 4.

R. S. W.

PRIZE SUBJECTS FOR SCIENTIFIC RESEARCH.

AT the annual meeting of the Société Batave de Philosophie expérimentale de Rotterdam, a series of forty-eight questions, or proposed researches, were put forward for the coming year. Amongst these are the following: an exact critical review of the present state of knowledge of the volcanoes and volcanic phenomena in the archipelago of the East Indies, and an explanation of the origin of these volcanoes based upon these data or upon the author's own researches; an experimental research on the cause of phosphorescence, especially in animals of a lower order; an experimental research on the electrical properties of some metallic alloys; an exact determination of the

indices of refraction at different parts of the spectrum of substances possessing anomalous dispersion, and a discussion of the bearing of these observations on the theory of dispersion of light; experimental determinations, carried out with the greatest care, of the atomic weight of at least one element, the value of which is at present uncertain; a critical discussion of the theories of flight and of the experimental researches which form the base of such a discussion; a theoretical and experimental examination of the causes of the deviations from Ostwald's dilution law; exact direct measurements of the osmotic pressure of solutions, not showing electrolytic dissociation, especially in view of the determination of the limit of concentration at which the deviations from the laws of Boyle and Gay-Lussac begin to be felt; a research on the origin and physiological signification of the green colouring matter in the bodies of articulated green animals; an experimental research on the electrolytic dissociation of substances dissolved in different mixtures of water and alcohol; a determination of the diminution of the vapour pressure of solutions in water of the chlorides of sodium, potassium, calcium, and magnesium between the temperatures 0° C. and 100° C. for at least six different concentrations, the molecular conductivity, the lowering of the freezing point, and the rise in the boiling point are to be determined for the same solutions, the whole to be discussed from the point of view of the theory of Arrhenius and the criticisms of Kahlenberg; a quantitative research on the radiation of two simple gases in a magnetic field; new quantitative determinations on the distribution of radium in the earth's crust; a study, as complete as possible, of the structure and development of one species of the genus Trypanosoma, *Tr. lewisi* for preference.

The gold medal of the society (or its value) is offered for the best paper received in answer to one of these questions. Replies should be written in Dutch, French, English, German, or Latin, not signed by the author, but bearing a motto, accompanied by a sealed letter containing the same motto and the author's name, and addressed to Dr. G. J. W. Bremer, the secretary of the society, at Rotterdam, before February 1, 1910.

PAPERS AND REPORTS ON INSECTS.

BULLETIN No. 3 of the Sleeping Sickness Bureau is devoted to the life-history of the tsetse-fly, *Glossina palpalis*, a species which appears to have been originally obtained in Sierra Leone, but is now known to have a very wide distribution, including Angola, Nigeria, the Congo State, the lake region, the Egyptian Sudan, Uganda, and north-eastern Rhodesia. After referring to the peculiar mode of propagation of tsetses, the author discusses the influence of external conditions on the distribution and numbers of the species under consideration, referring particularly to shade, altitude, season, temperature and humidity, forest, water, and food-supply.

A number of new species and one new genus of American mosquitoes are described by Messrs. H. C. Dyar and F. Knab in vol. lii. of the Smithsonian Miscellaneous Collections, as a preliminary to a monograph now in course of preparation by Dr. L. O. Howard and the authors of this paper. The new genus, Dinanamesus, is allied to Dinocerites, from which it differs by a reduction in the length of the second joint of the antennæ.

In the report of the entomologist of the U.S. Department of Agriculture for 1908, Dr. L. O. Howard refers to the work done during the year in connection with the Mexican cotton-boll weevil, a species which continues to inflict much damage on growing cotton. It has been found that parasites are year by year becoming much more effective in controlling the ravages of this weevil, a fact promising favourable results in the efforts of the Bureau to encourage and spread the former. During the season under review the average parasitism is shown to have been doubled in Texas and trebled in Louisiana. Special attention was also directed during the year to insects injurious to forests, and it is satisfactory to learn that the efforts of private owners and the forest officials to check and control the alarming outbreaks of the Black Hills beetle in the neighbourhood of Palmer Lakes and Colorado Springs, as well as in the adjoining Pikes Peak National Forest, have proved a complete success.

The whole of vol. xxxi., No. 1, of Notes from the Leyden Museum is devoted to a monograph, by Dr. H. W. van der Weele, on the Mecoptera (scorpion-flies) and Planipennia of "Insulinde." The latter name is taken to denote the Dutch colonies in the Malay and Papuan archipelagoes, but the paper, which is illustrated by five plates, includes descriptions of species from those parts of Borneo and New Guinea which do not belong to Holland. A number of new species and subspecies, and three new genera, are named and described in the course of the paper, while some interesting particulars are given with regard to the life-history of one of the species of "ant-lion" (Myrmeleon).

EXPLOSIVE COMBUSTION, WITH SPECIAL REFERENCE TO THAT OF HYDROCARBONS.[1]

IT is hardly necessary to remind you that the subject of my discourse will be ever associated with the illustrious name of Davy. Davy turned his attention to the phenomena of flame in the year 1815, in response to an urgent appeal on the part of a committee formed in the north of England, to investigate the causes of accidents arising from the explosion of fire-damp in coal mines, and to devise means for their prevention. The perennial interest of his researches, however, lies not so much in their immediate practical success, great as this undoubtedly was, as in the broader theoretical issues which were disclosed, and brought within the region of experimental inquiry, by so splendid an exercise of genius.

Davy insisted on the necessity of considering flames in all cases "as the combustion of an *explosive mixture* of inflammable gas, or vapour, and air," and he defined flame as "aëriform, or gaseous matter, heated to such a degree as to be luminous." For the starting and propagation of a flame in an explosive mixture, he showed that each successive layer of gas must be raised to a certain definite temperature, called the "ignition point," and he investigated both the ignition temperatures and the explosion limits of a large number of the commoner combustible gases. He then proceeded to his famous discovery that, notwithstanding the extremely high temperatures of flames, which, in the case of cyanogen, he estimated to be "above 5000° of Fahrenheit," they can be readily extinguished by contact with a cooling surface of sufficient area and heat-conducting power, and that for this purpose metal surfaces are by far the most efficient. How he developed and applied this discovery to the construction of his "safe-lamp" for miners is a matter of history.

In experimenting upon the ignition temperatures of explosive mixtures, Davy made the important observation that combustible gases combine with oxygen at lower temperatures without any appearance of flame whatever. He emphasised the importance of a complete investigation of the chemical aspects of this flameless combustion, and he himself was led to ask whether, seeing that the temperatures of flames far exceed those at which solids become incandescent, a metallic wire can be raised to incandescence by the slow combustion of two gases "without actual flame, but producing heat enough to keep the wire ignited." In this way he discovered the remarkable property of platinum and other metallic wires of inducing surface combustion, and in the course of his further experiments on this subject he made two notable observations respecting the burning of compounds containing carbon and hydrogen. He found "much carbonic oxide" produced when a platinum wire was kept incandescent by the slow combustion of a mixture of ethylene and oxygen, rendered non-explosive by an excess of the hydrocarbon and in a similar experiment with ether vapour he recorded the appearance of "a pale phosphorescent light" accompanied by "the formation of a peculiar acrid volatile substance possessed of acid properties."

Finally, in speculating upon the difficult and thorny subject of the luminosity of hydrocarbon flames, he was

[1] Abridged from a discourse delivered at the Royal Institution on Friday, Febrary 28, 1908, by Prof. W. A. Bone, F.R.S..